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XUM

CONTENTS.

PAGE.

EDITORIAL. 21

ON THE NATIONAL IMPORTANCE OF SCIENTIFIC RESEARCH, AND HOW LOCAL SOCIETIES MAY ASSIST ITS PROMOTION.
By B. B. Woodward, F.L.S., F.G.S. 22

AN EDUCATIONAL GARDEN. 26

THE FACE OF THE SKY.
By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S. 26

LONDON GEOLOGY. *By G. M. Davies, M.Sc., F.G.S.* 28

THE BRITISH SCIENCE GUILD AND THE EDUCATION BILL. 30

THE WEATHER AND ITS ANOMALIES.
By Tankerville Chamberlaine, Bey. 31

WOODEN SCRATCHING TOOLS MADE BY AN AFRICAN PARROT. *By Nina F. Layard, F.L.S.* 32

PAGE

NOTES.—
Astronomy.
By A. C. D. Crommelin, B.A., D.Sc., F.R.A.S. 35
Chemistry.
By C. Ainsworth Mitchell, B.A. (Oxon), F.I.C. 36
Geography. *By Alexander Scott, M.A., D.Sc.* 37
Geology. *By G. W. Tyrrell, A.R.C.S., F.G.S.* 37
Radio-Activity. ... *By Alexander Fleck, D.Sc.* 38
Zoölogy.
By Professor J. Arthur Thomson, M.A., LL.D. 38

CORRESPONDENCE.—
Dr. Bastian's Experiments on the Origin of Life.
By Albert Mary 40
Air Waves. ... ... *By W. F. Badgley.* 40

REVIEWS. 40

NOTICE. 40

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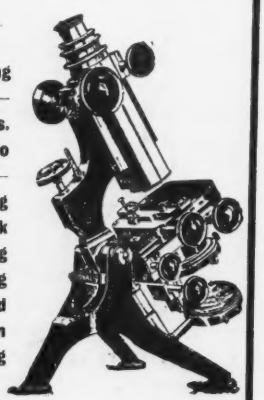

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OCTOBER to DECEMBER, 1917.

OUR first article is Mr. B. B. Woodward's Presidential Address to the Ealing Scientific and Microscopical Society. Its object is to show the importance of biological research and the need for the natural history sciences to be represented on the Committee of the Privy Council for Scientific and Industrial Research. We think that a clear case has been made out by Mr. Woodward, and we give below the draft of a Memorial which has been prepared for signing. We hope that any of our readers who feel strongly on the point will copy it out and send it to us with their signatures. If we have any criticism whatever to make, it is that more than one representative in biology should be added to the Committee.

"*To the Lords of the Committee of the Privy*
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"That your Memorialists would earnestly urge "that your Lordships would be pleased to extend "your proceedings at the earliest possible oppor-"tunity to the Natural History Sciences, and that "your Lordships will add to your Assessors a "representative of those Sciences."

DURING the last few years, attention has again been directed to the old question of the occurrence of great alternations of climate in the British Isles during the Glacial period. Till recently most authorities held that we have in this country traces of only one single glaciation, but in the light of recent work in Switzerland and elsewhere this opinion is obviously in need of revision. In the Alps, Penck and Brückner have clearly established four glaciations with warmer periods between, and it is, on the face of it, probable that these variable conditions would be reflected in the British Isles. Owing probably to the power of a preconceived opinion, some of the evidence that really exists has scarcely received the attention it deserves; such as, for example, the sections at Hoxne, in Suffolk, and at Kirmington, in Lincolnshire, as well as the Arctic plant-beds in the Scotch peat-mosses.

Two or three years ago Professor Marr and Miss Gardner discovered at Cambridge a most interesting Arctic plant-bed that is certainly newer than the shell-bearing gravels of Barnwell, which contain *Corbicula fluminalis*, *Unio littoralis*, and other forms now characteristic of a distinctly warm climate. Professor Marr has been working for several years on the gravels of the Cambridge district, and he has now rendered a great service to geology in general, and to glaciology in particular, by publishing in the *Proceedings of the Cambridge Philosophical Society* a preliminary account of some of his results. Many of these gravels contain palaeolithic implements as well as bones and shells, and Professor Marr has been able to put forward a suggested correlation of the different gravels of East Anglia with the Alpine glacial periods of Penck and Brückner and with the established subdivisions of palaeolithic culture. The Chillesford Crag is taken to represent the first glaciation, the Chalky Boulder Clay the second, the Observatory gravels the third, while the Arctic plant-bed before mentioned is the fourth. The Observatory gravels form part of the "Gravels of the Ancient River System" of former authors. They contain implements of Chellean, Acheulean, and Mousterian types, the older ones being possibly derived from some other deposit. It is to be hoped that workers in other districts will devote their attention to similar researches bearing on this most important problem of the climatic variations of the Glacial period. For this purpose it is essential that the exact locality of all finds should be most carefully recorded, and that all specimens should be made accessible by being placed in public museums

XUM

ON THE NATIONAL IMPORTANCE OF SCIENTIFIC RESEARCH, AND HOW LOCAL SOCIETIES MAY ASSIST ITS PROMOTION.*

By B. B. WOODWARD, F.L.S., F.G.S.

THE subject to which I wish to direct your attention to-night may perhaps be less attractive than is usual in an Annual Presidential Address, but, as I hope to convince you, is one calling for consideration on account of its importance and the possibility of this society's aiding in furthering its progress.

And here, before I forget it, let me return thanks to many of my colleagues at the Natural History Museum and other friends to whom I am indebted for assistance, and also acknowledge that I have freely drawn on published sources of information.

For more than three years now we have been traversing, as it were, a dark tunnel through the mountain of trouble which has overwhelmed almost the whole of Europe; but at length a glimmer of daylight is visible at the still far distant end. What will await us when we once more emerge into free air? We cannot expect to find ourselves in unaltered environment. The old order will have changed—what will the new be—what our part in it? We are surely well justified in taking counsel in advance as to this coming era of reconstruction; in erecting, so to speak, our own Department of Reconstruction; for the motto of Ealing is not only "Respice," but also "Prospice."

Now one outcome of the present world-war, so far as this country is concerned, has been the tardy recognition that the importance of Science and scientific research, in relation to the economy of the nation, has been grossly underrated in the past, and that this woeful neglect had well nigh led to disaster. As Lord Montagu of Beaulieu remarked at a meeting convened to deal with the neglect of Science in May last year, "The attitude of the nation towards Science is not one of dislike, but of contemptuous neglect."

This recognition resulted in the establishment by Order in Council on 28th July, 1915, of a "Committee of the Privy Council for Scientific and Industrial Research," and funds for the carrying out of its objects have been placed at its disposal by Parliament.

The objects proposed, as set forth by their "Advisory Council," which was constituted at the same time, may be summarised as the institution of special researches; the establishment or development of special institutions for the scientific study of problems affecting particular industries and trades; and the establishment and award of Research Studentships and Fellowships.

This committee has now issued two Annual Reports, which detail the work so far carried out, all of which has been in the main, as they admit, addressed to the organisation of industrial research. They concede that "there are not two different kinds of Science"; that no distinction can be made between pure and applied, the former being the necessary precedent of the latter; and confess that "it is impossible . . . to be sure that a particular line of research will lead to a positive result. On the other hand, it will often suggest a diverging inquiry that, if followed up, may produce results even more valuable than the original question." Not only is this true, but too exclusive a concentration on the quest for profitable results may even prove positively detrimental in any branch of scientific research by causing a neglect of such clues to other results than those immediately sought for.

The Committee, however, plead the more immediate necessities for industrial research, "because the influence of the war has created in industry an atmosphere conducive to the growth of new ideas, whereas it has unfortunately made the prosecution of work in pure Science a matter of extreme difficulty" largely by calling out into the field of war the necessary students and teachers, whilst at the best of times they acknowledge Science "finds too few suitors in our industries; for she is a mistress who reserves her favours for a complete and single-hearted devotion."

Still the Committee hope that their labours will, as the Report has it, "help to achieve that revolution in the attitude of Your Majesty's subjects towards scientific thinking, without which no expenditure of money on industrial research, however lavish, will avail." This is clearly an admission that the study of Science for its own sake as a branch of knowledge is still not in favour with either those rich in the ignorance begotten of a too exclusively classical education, or those who seek solely to exploit it for the pursuit of riches; both of whom suffer from the defect of not having plumbed the depth of their own nescience.

Far as all this takes us on the right road, there is nevertheless one drawback, and one that largely concerns a society such as this, namely, that the "pure science" of the Committee obviously does not include the Natural History Sciences. It is true that both Geology and Botany are alluded to; but one is rather led to infer that the Geology may be that connected with the search for materials suitable for glass-making, or fuels, and so forth, and the

* Presidential Address to the Ealing Scientific and Microscopical Society, November, 1917.

XUM

Botany with wood for aëroplanes. There is certainly no allusion to the Natural History Sciences as such, nor in the list of assessors is there included any department, institution, or person competent to represent their interests or advise the Committee in such matters.

That this is a serious omission, and one gravely affecting the interests of national welfare, is my object to make clear to-night.

In the first place let me recall some conspicuous instances of the origination of certain important agents now in every-day use from adventitious discoveries conducted without any utilitarian object in immediate view.

To begin with those which war has brought into prominence :—

GUNPOWDER is attributed to experiments by Roger Bacon, who (*circa* 1265) blundered upon it whilst playing with some incendiary composition, but was unaware of its propelling power. This was not utilised till 1326, when guns were invented, appropriately enough by a German monk, one Berthold Schwartz.

GUN-COTTON, invented by Schönbein in 1845–6, and NITRO-GLYCERINE, first obtained by Ascanio Sobrero in 1846, were laboratory experiments till Nobel turned them to account in 1863.

The BALLOON originated in experiments without any ulterior motive by the brothers Montgolfier, in 1783. Ten years later the French employed them in war, but the Dirigible and the Zeppelin are creatures of our own times.

AEROPLANES, or heavier-than-air flying machines, were foreshadowed in Henson's flying machine, designed in 1843; but to Langley, of the Smithsonian Institution, belongs the credit of constructing, in 1896, the first aëroplane on the modern lines that really flew. At the time his experiments were regarded as the trivial amusements of a scientific man.

The ELECTRIC MOTOR and the DYNAMO owe their existence to laboratory experiments conducted by Faraday in 1821 and 1831 respectively.

The ELECTRIC TELEGRAPH is based on Volta's production, in 1800, of a continuous current of electricity, combined with Oersted's accidental discovery, in the course of a lecture in 1819, that a magnetic needle was deflected when brought near such a current. It was Ampère, later on, who suggested the utilisation of this for signalling at a distance; and Morse, who carried it out in 1835, employing, however, the induced current, discovered by Faraday; whilst to Cooke and Weatstone, following, in 1837, the lines of Oersted's discovery, is due the modern telegraph, of which the first public line was opened in 1843 between Paddington and Slough.

SUBMARINE CABLES soon followed, and in 1851 the first was laid between Dover and Sandgate; whilst, after an abortive attempt in 1857, the Atlantic was spanned in 1865. The successful laying of a submarine cable demands a knowledge of the sea floor over which it is to pass; and thus it came that the deep-sea soundings, at first conducted simply in the interests of Science, acquired a practical value. It was largely, indeed, to this end, and in quest of such knowledge, that expeditions like that of the "Bull Dog" were fitted out.

WIRELESS TELEGRAPHY, again, originated in laboratory experiments by Hertz, who, in 1886–7 provided experimental proof of the electric waves now called after him; whilst Lodge, in 1894, obtained signals by means of them over a distance of half a mile. It was reserved for Marconi, however, in 1899, finally to turn them to practical account.

If all these have been mainly utilised on the destructive side of warfare, there are others which may be regarded as antidotes, so to speak. For example :—

X RAYS were the fortuitous discovery by Röntgen, in November, 1895, when experimenting with a Crookes tube, and members will recollect that a public lecture on the photographic results obtained by means of these rays was given, under the auspices of this society, in the Victoria Hall as early as March of the following year.

The application of these rays to the purposes of surgery was quickly made, and has more than once formed the subject of Dr. Deane Butcher's luminous addresses to us. At the present moment the Ealing Chamber of Commerce is praiseworthily raising a fund to present an installation to our hospital, where its need has been greatly felt.

In therapeutics generally, however, accidental discoveries are infrequent; by observation and experiment mainly have advantageous facts been established.

The whole series of valuable protections by VACCINATION practically originated in the observation of the anonymous Gloucestershire milkmaid, that to have had cow-pox was a safeguard against small-pox; for her remark started Jenner on the investigations, lasting thirty years—so cautious was he—that resulted in his treatment for small-pox by vaccination.

It was a chance observation by Pasteur, primarily a crystallographer, occasioned by one of his laboratory preparations going mouldy, that led to his study of ferments, and so to the whole series of important discoveries in regard to the connection of micro-organisms with disease, and thence to toxines and anti-toxines; whilst Pasteur's work in turn led to Lister's application of its principles to surgery and the healing of wounds.

Turning next to the Natural History Sciences the same story is practically repeated.

MINERALOGY.—It is not too much to say that modern applied Mineralogy and Metallurgy date from 1861, when H. C. Sorby first introduced his method of studying thin rock-sections under the microscope, and thence evolved the technique of preparing highly polished surfaces of metals, and

then etching them with acid to bring out the structure. His methods, instituted purely in the interests of scientific knowledge, are now daily practised for the control of industrial operations.

GEOLOGY.—Although Hutton has been regarded as the founder of Geology, William Smith, the "Father of English Geology," was the first, by his discoveries, to place it in a position of practical utility. By profession a surveyor, he became interested in the different soils and strata; and as the result of his studies, announced, in 1796, the important doctrine that "each stratum contained organised fossils, peculiar to itself," by which it could be identified, and further showed that those strata followed a definite order of succession. His discovery gave a zest to the study of Geology, which was then becoming a vogue in the scientific world, and doubtless assisted towards the foundation of the Geological Society in 1807. It was not, however, until 1835 that the practical utility of the science was recognised by Government, and the "Geological Survey of the United Kingdom" instituted. Official support, all the same, has never been wholehearted, or still better results might by now have been obtained; and it has been entirely owing to the splendid zeal of its successive officers, from highest to lowest, through all these years, aided by assistance from earnest students all over the country, that so much real good sound work has been accomplished. Even now our Geological Survey is not given its proper place among national institutions, where it only figures as an appanage of the Board of Education. Here, for certain, is one thing needing reform. How can we properly know what the mineral resources and wealth of our country may be if the country has not been thoroughly explored and mapped? And proper mapping implies a full knowledge of the composition of all the various rocks, with their fossil contents, where such exist, gained by the work of specialists. A fragmentary fossil, only recognisable by an expert, is often the only indication in a boring to show whether success or failure would attend further operations. Many a man has been saved expense by the trained geologist, and not a few of those practical men who always know better than the expert, declining warning, have experienced the mortification of sinking bore-hole and money without any return.

BOTANY is the one among the natural history sciences that obviously had a practical origin. The search for medicinal herbs and the necessity for discriminating them from other plants laid the foundations of the science. Hippocrates, Theophrastus, Dioscorides, and their successors down to mediaeval times all studied and wrote on Botany from the medical point of view, and it was only gradually that systematic Botany, as we know it, was built up.

Nevertheless, pure or systematic Botany is the foundation of all further knowledge on the subject. Until plants have been attentively studied and the various kinds carefully differentiated, how is it possible to distinguish in closely allied species poisonous from edible, destructive from innocuous, the really useful from the less useful, or even useless? The fungi we meet with in our rambles will yield samples of the first; those with which the cultivator has to contend illustrate the second; whilst for the third case examples, it is said, exist in some rubber plantations which owe their non-success to the choice by the planter's collector of the wrong species out of two or three very similar kinds—a blunder the systematic botanist would have detected.

Good botanical surveys have been made of many of our colonies, dominions, and India, but some colonies remain as yet unexplored, and our knowledge of their floras is limited to the collections made by chance travellers or Government officials, with whom it has been a labour of love. It is surely of the utmost importance that these shortcomings should now be remedied, and properly organised surveys, conducted or supported by the State, be instituted.

ZOOLOGY, equally with Botany, is based on systematic study, although the paramountcy of pure or systematic Zoölogy is perhaps more evident in the study of the Invertebrata than of the Vertebrata. The latter, on acoount of their comparative paucity and size, make less demand on the discriminating faculties than do, for example, the Insects, which have come of late to figure so largely in the question of the spread of disease, although, as a matter of fact, they have long been suspect.

Indeed, it was as far back as 1577 that the Italian physician, Mercurialis, suggested that the plague was spread by Flies; whilst Bancroft, in 1769, advanced the theory that "yaws" was transmitted by Flies, just as we now know the germs of typhoid and other kindred diseases are brought into our houses from his foul resorts by the Common House Fly (*Musca domestica*). It is hardly a digression to note here that what becomes of this pest in winter is as yet a mystery, requiring solution in the interests of hygiene. It does not hibernate in our houses as do two closely similar species constantly mistaken for it, namely, *Musca autumnalis* and *Pollenia rudis*.

The Common House Fly, however, is not a biting insect, and convection in its case is fortuitous, whereas the blood-sucking Flies and Gnats innoculate the object of their attack with the disease-producing parasites that pass one stage of development in their own bodies. Thus Mosquitoes, suspected before, were proved by Manson, in 1878, to convey *Filaria*; by Finlay, in 1881, to communicate yellow fever; and by Ross, in 1898, to spread malaria; whilst a Tabanoid Fly is the vector of the Indian cattle disease, "Surra"; and the various Trypanosome diseases of Africa, including the fatal "sleeping sickness," have as their intermediate hosts different

species of Tse-tse Flies. Each of these diseases has its own particular insect vector.

Fleas transmit various germs, including those of the plague, whilst Bugs, Lice, and some Ticks are equally blameworthy.

Nor must Mollusca be overlooked in this connection, for one particular Water-snail is the intermediate host of the Liver-fluke, whilst more than one in Egypt assists in the spread of Bilharzia.

Our food, including Army biscuits, is in all its stages liable to destruction by Microlepidoptera, Beetles, and other insects in one or other of their metamorphoses; nor does our clothing escape the attentions of the first named. The study of these and the various other insect plagues with which the husbandman, forester, and gardener have to contend now constitutes the special branch—Economic Entomology—of which Miss Ormerod was practically the pioneer.

Now in all these cases the task of discriminating those species that are harmful from those that are innocuous, and recognising those that are beneficial, because they attack the harmful ones, falls to the systematist. Thus it has come about that the study of insects, at one time considered a foolish if harmless waste of time, is now shown to be of the greatest importance. Pure Zoölogy is therefore the basis of the whole science and its applications, and, equally with Pure Botany, demands extended knowledge.

Unfortunately, our acquaintance with the faunas of the different parts of our Empire is even less complete than that with their floras, and for the same reasons.

Thorough and systematic surveys are badly needed, and in this respect we would do well to learn of our enemy. The Germans have been far ahead of us in this matter, both as regards their own country and their late colonies, whilst State-supported explorations have been made by them in other parts, not, perhaps, entirely from disinterested motives. Nevertheless the scientific results obtained have been unreservedly published and placed at the disposal of the scientific world.

Such expeditions as this country has undertaken have been mainly conducted for some more immediate end other than that of the acquisition of knowledge for its own sake, and, least of all, for the benefit of Natural Science. In Cook's days the chief object was undoubtedly to forestall the chance of acquisition of possible new territories by a rival nation. Later voyages were more concerned with the charting of the seas for Admiralty purposes, or the investigation of physical phenomena bearing on navigation. None, save the "Challenger" Expedition, contemplated assigning more than a subordinate position to the Natural Sciences, and so alarmed, apparently, were the authorities at the expense in which the publication of the scientific results of the "Challenger" Expedition involved them that the experiment has not been repeated, and subsequent expeditions have had to be content with a modest subvention from Government, supplemented by voluntary subscriptions and proceeds earned by lectures and cinematograph displays.

Even our own British Islands have not been completely surveyed with a view to their economic and other resources. Our few scattered marine biological stations, mainly the outcome of private endeavour, have not been adequately supported, nor means taken for coördinating their work; whilst our inland waters, with their hidden possibilities, are untouched, save for the Sutton Broad Biological Laboratory, built and worked from 1902 by the brothers Eustace and Robert Gurney.

It is not possible to say more within the severely restricted limits of an Address, but enough has, I think, been said to prove the contention that the Natural History Sciences are of vital import in the economy of the nation, and that the practical advancement of their study is an object worthy of national support. Such national support can only be forthcoming if the governing authorities have the assurance there is behind them a sufficient body of public opinion to justify their action in giving State aid. Put in somewhat homely phraseology, the position is very much what we witnessed during the gradual realisation by the great sister nation across the Atlantic, that the present European turmoil had a real live interest for it, when the point was reached at which the Press of the country announced to their great Chief of State: "We are behind you, Mr. President"; and a little later: "We are behind you, Mr. President; don't tread on us!" It is necessary to convince the Lords of the Committee of the Privy Council for Scientific and Industrial Research that the public is not only supporting their efforts, but that they are not proceeding fast enough for public opinion. Their Annual Reports show that they are willing to proceed further; it is for us to strengthen their hands and encourage them on the road. With this object in view, we can not only address a memorial to them ourselves, but we can invite the kindred societies all over these islands to do likewise. Both these courses we should, I think, adopt. Peradventure some of the older parent societies, which are not local, may be moved to coöperate.

In the mission of arousing the public interest there is, furthermore, a field open to each individual member of this and similar societies, namely, as opportunity shall serve, to interest and convince our non-scientific friends (who, as a matter of fact, are, as a body, indifferent rather than hostile) that research in the Natural History Sciences has a direct bearing on their daily life and welfare, and that, though they personally may not be interested in these sciences, they are deeply concerned in their application, and should therefore support their advancement in every way.

Moreover, there is practical spade-work which

we and, above all, more fortunately situated societies can do, each in its own district. For instance, assistance can be rendered in recording the occurrence of the Anophiline Mosquitoes, as requested by the Local Government Board in their recent circular to which your attention has been drawn.

Practical support might also be given to the "Committee for the Development of Regional Survey" by assisting in the compilation of reliable lists of the fauna and flora of the district, work that would afford pleasurable and healthy occupation in such of the surrounding country as is left us during leisure hours in the summer of the coming year.

There was a time in the history of this society when such an attempt was made, for early in 1885 a "Fauna and Flora Sub-Committee" was instituted and some good work done. A list of Fossils was drawn up by Mr. J. Allen Brown, and of Lepidoptera by Mr. F. E. Fenton. What may be regarded as a preliminary list of the birds was compiled by the Secretary, Mrs. A. Belt, and was published with the Eleventh Annual Report; whilst a later, more complete and annotated list, by Mr. R. H. Read, appeared with the Nineteenth Annual Report in 1896. Meantime lack of support from the body of the members caused the gradual decline of the Sub-Committee, all reference to which ceases after the 1896–7 Report, the sole survival of its existence being the annual *Meteorological Record*, first begun under its auspices in 1889. One would like to see this system of local research reinstituted, and possibly when more normal conditions of life return with the recurrence of peace, it may be practicable, given a certain number of willing workers. It is a pity that we have no local museum in which local specimens could be stored and consulted.

So much for the subject of to-night from its mundane point of view.

There is another aspect. Poverty-stricken, indeed, is the nation that does not take this also into account, and fixes its attention too exclusively on the practical results to be obtained from scientific research.

There is a dual nature in Man, and his higher and better nature is only to be reached and developed as it should by the study of Science for its own sake; for what can lead more surely than Science, and especially the study of its Natural History branches, to a truer and more just conception of the *Causa Causans*, the Great Architect of the Universe?

"Work and pray" is a good maxim that has come down to us from the past. Work is good. Prayer is good, especially if conceived in its more extended meaning, the meaning given to it by Coleridge's "Ancient Mariner":—

> "He prayeth well who loveth well
> Both man and bird and beast.
>
> He prayeth best who loveth best
> All things, both great and small;
> For the dear God who loveth us
> He made and loveth all."

AN EDUCATIONAL GARDEN.

THE somewhat novel scheme of adapting a private garden for educational purposes has for several years been in operation at "Westfield," Reading, with the object of giving the public, and especially teachers and school-children, the opportunity of observing and studying plants used in industry and commerce.

A number of plots has been laid out by Dr. J. B. Hurry, in which are grown a large variety of economic plants. The first series includes plants used in medicine, such as belladonna, aconite, podophyllin, asafoetida, valerian, henbane, cinchona, and the opium poppy. The next consists of plants used for food, *e.g.*, maize, millet, sugar, rice, banana, and arrowroot. The third includes plants used for clothing and textiles, such as flax, hemp, cotton, jute, and ramie. The fourth series is made up of plants that yield dyes, such as woad, indigo, madder, and alkanet.

In the several conservatories there are exhibited more delicate economic plants, such as tea, coffee, soya beans, monkey-nuts, cinnamon, and camphor. In a small museum adjacent various products made from the above-mentioned plants are placed, with descriptive labels, so that the two can be studied together.

In another part of the grounds is an Old English herbary, in which may be seen about sixty kinds of herbs, such as in former years were used for potage, salad, simples, scent, or other purposes.

Every summer the garden, conservatories, and museum are thrown open free on several half-holidays to visitors who avail themselves of the privilege of seeing some of the important plants used in industry. A printed catalogue is supplied to every visitor, and from time to time demonstrations on the more interesting exhibits are given.

THE FACE OF THE SKY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE SUN passes the winter solstice December $22^d\ 10^h\ m$. The shortest evening is on December 14th: Sunset $3^h\ 49^m$. The shortest morning is on December 29th: Sunrise $8^h\ 8^m$. February 1st: Sunrise $7^h\ 42^m$; sunset $4^h\ 46^m$. March 1st: Sunrise $6^h\ 49^m$; sunset $5^h\ 37^m$.

Perihelion occurs on January 1st at $5^h\ e$; vernal equinox, March $21^d\ 11^h\ m$.

Considerable solar activity continues, and there is as yet no evidence that the maximum is past. It is as well to give ample notice of the total solar eclipse of June 8th, 1918. The shadow will cross U.S.A. diagonally from N.W. to S.E. The Sun will be fairly high in the Western States, low in Florida. Denver is within the track of totality, and is a convenient station for observation. Totality there lasts one and a half minutes. The following points are on the central line: 124° 1′ W., 46° 47′ N., 111° 16′ W., 42° 18′ N., 99° 26′ W., 37° 2′ N., 86° 38′ W., 30° 54′ N. This eclipse is a return of those of 1882 (Egypt) and 1900 (U.S.A.,

Spain, Algiers). Both were favoured by fine weather and were successfully observed. A small comet was discovered near the Sun during the 1882 eclipse. The two succeeding returns will also be conveniently placed. That of 1936 will be total at Constantinople, that of 1954 grazes the Shetlands and crosses South Norway. There will be other total eclipses of the Sun in U.S.A. in September, 1923, and January, 1925.

THE MOON.—The following are the dates of New Moon (N.) and Full Moon (F.): December 14d N., 28d F.; January 12d N., 27d F.; February 11d N., 25d F.; March 12d N., 27d F. The spring is the best season for studying the young Moon, as it is then north of the Sun. Many occultations are observable: some of the brighter ones may be noted. December 27d 9h 2m *e*, 1 Gemin. Dis.; December 28d 3h 26m *m*, 2 Gemin. Dis., Re. 4h 5m *m*; 28d 6h 57m *m*; μ Gemin. Dis.; January 30d 11h 56m *e*, *e* Leonis Re.; February 20d 5h 30m *e*, μ Gemin. Dis.; March 19d 9h 42m *e*, η Gemin. Dis.; March 20d 6h 31m *e*, ζ Gemin. Dis.

The lunar eclipse of December 28th (morning) may be seen in Ireland just before sunrise.

The following are the dates of maximum libration, the letters E., W., N., S. indicating the region of the Moon's limb most brought into view. E., December 12th, January 9th, February 6th, March 7th; W., December 26th, January 22nd, February 18th, March 18th; N., December 8th, January 4th, January 31st, February 27th, March 26th; S., December 21st, January 17th, February 13th, March 13th. Lunar observers should take advantage of these dates to study the region brought into view provided that it is illuminated by the Sun.

MERCURY is in elongation as an evening star on December 18th (sets 1h 20m after sunset) and April 7th (sets 2h after Sunset); as a morning star January 25th (rises 1½h before Sunrise). The position in April is a favourable one for observation, as the planet is north of the Sun.

VENUS is in elongation as an evening star early in December, setting 3h 20m after Sunset. It is then half full. It will be well placed for observation in January, being at its greatest brilliancy on January 5th. It is in inferior conjunction February 10th, 8° N. of the Sun. It will be badly placed for observation as a morning star in March and April, being south of the Sun. December 17th will be a favourable day for looking for Venus in daylight, as the crescent Moon will form a guide to it. At 3h *e* the planet will be 5° east of the Moon, 3° south of it. They will be considerably closer at setting.

MARS is approaching opposition, being nearest the Earth on March 18th, when its distance is sixty-one and a half million miles. It is an unfavourable opposition as regards distance, but favourable as regards its north declination.

		R.A. h. m. s.	N. Dec. ° ′
First Stationary Point ...	Feb. 4 ...	12 16 48 ...	2 0
Nearest Earth	Mar. 18 ...	11 38 48 ...	6 21
Second Stationary Point ...	April 27 ...	11 3 57 ...	8 21

The zero meridian (that through Fastigium Aryn) is central at 4h 18m *e* on January 21st, March 2nd, April 12th. It gets later by about 36m daily.

JUPITER was nearest Earth on November 27th, but will remain well placed for observation till the spring. It is stationary January 26th, R.A. 3h 57m 29s, N. Dec. 19° 48′, some 5° S.E. of the Pleiades. The equatorial diameter is 45″ in December, 35″ in March.

TRANSIT OF ZERO MERIDIAN.—System I, January 1d 9h 24m *e*, March 2d 6h 37m *e*. II, January 1d 5h 4m *e*, March 2d 4h 57m *e*.

Interval between transits, 9h 50m·6 (System I), 9h 55m·8 (System II).

The following table gives every twentieth transit and eclipse of Satellite I, every tenth of II, every fifth of III. Approximate intervals between successive occurrences, 1d 18h 29m for I, 3d 13h 18m for II, 7d 4h 0m for III.

Sat.		Tr. Ing. d. h. m.	Shad. Ing. h. m.	Tr. Egr. h. m.	Shad. Egr. h. m.
I.	Dec.	19 4 58 *e* ...	5 29 *e* ...	7 8 *e* ...	7 39 *e*
	Jan.	24 1 55 *m* ...	3 4 *m* ...	4 5 *m* ...	5 14 *m*
	Feb.	28 11 22 *m* ...	0 40 *e* ...	1 31 *e* ...	2 51 *e*
	April	4 9 13 *e* ...	10 17 *e* ...	11 24 *e* ...	0 28**m*
II.	Dec.	17 10 13 *e* ...	11 11 *e* ...	12 42**m* ...	1 42**m*
	Jan.	22 10 3 *m* ...	0 23 *e* ...	0 34 *e* ...	2 54 *e*
	Feb.	26 10 53 *e* ...	1 34**m* ...	1 26**m* ...	4 5**m*
	April	3 0 29 *e* ...	2 41 *e* ...	3 2 *e* ...	5 14 *e*
III.	Dec.	19 5 10 *e* ...	7 10 *e* ...	7 1 *e* ...	9 17 *e*
	Jan.	24 10 32 *m* ...	3 12 *e* ...	0 36 *e* ...	5 24 *e*
	Mar.	1 5 57 *m* ...	11 16 *m* ...	8 12 *m* ...	1 34 *e*
	April	6 3 0 *m* ...	7 19 *m* ...	5 25 *m* ...	9 44 *m*

		Oc. Dis. d. h. m.	Oc. Re. h. m.	Ecl. Dis. h. m.	Ecl. Re. h. m.
I.	Dec.	20 2 11 *e* ...	— ...	— ...	4 55 *e*
	Jan.	24 11 10 *e* ...	— ...	— ...	2 33**m*
	Mar.	1 8 40 *m* ...	— ...	— ...	0 12 *e*
	April	5 6 33 *e* ...	— ...	— ...	9 50 *e*
II.	Dec.	19 4 47 *e* ...	— ...	— ...	8 18 *e*
	Jan.	24 4 27 *m* ...	— ...	— ...	9 16 *m*
	Feb.	28 5 8 *e* ...	7 41 *e* ...	7 46 *e* ...	10 18 *e*
	April	5 6 39 *m* ...	— ...	— ...	11 22 *e*
III.	Dec.	16 3 21 *m* ...	— ...	— ...	7 7 *m*
	Jan.	20 8 35 *e* ...	10 39 *e* ...	1 4**m* ...	3 18**m*
	Feb.	25 3 48 *e* ...	6 4 *e* ...	9 8 *e* ...	11 28 *e*
	April	2 0 43 *e* ...	3 8 *e* ...	5 11 *e* ...	7 37 *e*

The asterisk indicates the day following that given in the date column.

IV is in superior conjunction: December 8d 10h *m*, 25d 1h *m*, January 10d 4h *e*, 27d 8h *m*; February 13d 1h *m*; March 1d 7h *e*, 18d 2h *e*; April 4d 10h *m*. It is in inferior conjunction midway between these dates.

SATURN.		R.A. h. m. s.	N. Decl. ° ′
First Stationary Point ...	Nov. 26 ...	9 8 54 ...	17 9
Nearest Earth	Jan. 31 ...	8 55 20 ...	18 17
Second Stationary Point	April 9 ...	8 41 6 ...	19 15

On January 31st major axis of ring 46″, minor 14″; south surface visible, polar diameter of ball 19″.

The ring is now closing, and will be turned edgewise in 1920.

NEPTUNE is in opposition January 26th, R.A. 8h 32m 12s, N. Decl. 18° 41′. Motion in 24 days – 2m 44s, N. 10′.

It is near Saturn in Cancer.

COMETS.—Encke's Comet is due to return to perihelion on March 25th next. This is a less favourable return than the last for Northern observers. The comet was photographed in the autumn of 1916, when only a month past aphelion.

The following ephemeris is by M. Viljev, approximately extended for January.

		R.A. h. m. s.	N. Decl. ° ′	Log *r*.	Log Δ
Dec.	2.....	22 48 27 ...	3 23 ...	— ...	—
,,	6.....	22 48 29 ...	3 12 ...	0·2762 ...	0·2054
,,	10.....	22 49 3 ...	3 4 ...	— ...	—
,,	14.....	22 50 8 ...	3 0 ...	— ...	0·2130
,,	18.....	22 51 45 ...	3 0 ...	— ...	—
,,	22.....	22 53 50 ...	3 3 ...	0·2307 ...	0·2188
,,	26.....	22 56 22 ...	3 9 ...	— ...	—
,,	30.....	22 59 19 ...	3 19 ...	— ...	0·2218
Jan.	3.....	23 2 39 ...	3 31 ...	— ...	—
,,	7.....	23 6 20 ...	3 46 ...	0·1768 ...	0·2212
,,	11.....	23 10 21 ...	4 4 ...	— ...	—
,,	15.....	23 14 40 ...	4 25 ...	— ...	0·2161
,,	19.....	23 19 16 ...	4 49 ...	— ...	—
,,	23.....	23 24 7 ...	5 14 ...	0·1133 ...	0·2057

ZODIACAL LIGHT.—January to March is the best time for observing this faint object. It should be looked for in the west, along the ecliptic, at the end of twilight, in the absence of the Moon.

LONDON GEOLOGY.

By G. M. DAVIES, M.Sc., F.G.S.,

Author of "Geological Excursions round London."

It is forty-five years since Charles Kingsley published his lectures on "Town Geology," given to the Chester Natural Science Society in 1871. Now that railway restrictions compel us to curtail our geological excursions, we may with advantage follow Kingsley's example and turn to the materials at hand in any large town to illustrate geological teaching. The students of one London college began their field work this year with an examination of some of the building and ornamental stones used in London, and the following notes may be useful to others who care to go and do likewise.

Starting from Dover Street Station, on the Piccadilly Tube, turn to the left along Piccadilly for a few yards. On the farther side of Old Bond Street good examples of Shap granite will be seen in the shop-front at the corner. This granite, from quarries on Shap Fells, in Westmorland, is easily distinguished by its large tabular crystals of pink or brown orthoclase felspar. The remainder of the rock is of finer texture, and consists essentially of quartz, felspars, and biotite. Dark-coloured patches of more basic material often occur, to the detriment of the appearance of the stone, as may be seen in this example.

Return along Piccadilly and cross over to St. James's Street, noticing the insurance offices at the corner with their façades of white marble. This marble comes from the quarries on the slopes of Mount Pentelicon, eight miles north-east of Athens, which yielded the stone for the Parthenon and most of the ancient Greek statuary. It was also used by the Roman sculptors until the Carrara marble came into general use.

Walk down St. James's Street, descending the slope from the gravel, sand, and brick-earth of the Middle Terrace to those of the Low Terrace (Figure 11). These old river deposits here have surface levels

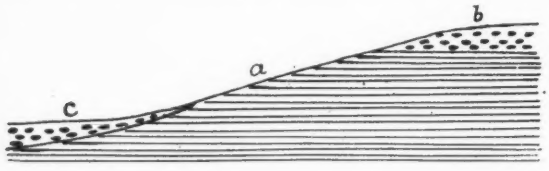

FIGURE 11.

Section (not to scale) along St. James's Street.

a, London Clay. *b*, Middle Terrace. *c*, Low Terrace.

about sixty and thirty feet above Ordnance Datum. The slope may be traced south of Piccadilly and Knightsbridge to Kensington, and eastward to the Temple, where the river was cutting into the Middle Terrace until restrained by human works. The terraces are trenched by small valleys formed by streams which rose in the Bagshot Sands of Hampstead and Highgate. These streams have long since disappeared into sewers, but their names survive as names of streets or districts. They were known as the West Bourne, the Ty Bourne, and the Hol Bourne, or Fleet Ditch, with the shorter Wall Brook within the City itself. In parts of the West End the brick-earth and sometimes the gravel have been dug out before building commenced; the roads and squares are left at the original level of the ground, the houses have basements and areas, and the interiors of the blocks are occupied by mews at a lower and artificial level. One of the clearest examples of such excavation is seen in the gardens of the Natural History Museum in Cromwell Road.

The rain that falls on the Middle Terrace, or such rain as is not led at once into the drains, passes through the gravel and tends to re-appear as springs on the slope between the terraces. Consequently the houses in Jermyn Street, near the base of the gravel, are liable to flooded cellars, if not well cemented, and also to cracks in the walls through displacement of the foundations. Such cracks appeared in the Museum of Practical Geology a few years ago. Before leaving the subject of the gravel terraces we may notice the utility of the London Clay in solving London's traffic difficulties. When the old shallow underground railways were constructed, much trouble was caused by the water encountered in the gravels; but in the London Clay the tube railways found a material easily excavated and free from circulating water. In open cuttings, however, London Clay is a nuisance owing to its tendency to slip.

At the foot of St. James's Street turn to the left along Pall Mall. The imposing front of the Royal Automobile Club, in Portland Stone, will be noticed on the right; but in most of the other clubs the stone is too blackened by London smoke to be easily distinguishable.

At the end of Pall Mall bear to the right along Cockspur Street, where the shipping companies' offices show a variety of handsome building stones. The most striking is that known as "laurvikite," seen in the premises of the Allan Line and the Canadian Pacific Railway, where both the dark and light varieties have been used. This is an augite-syenite rich in soda, from near Christiania, in Norway. The mass of the rock is made up of soda-orthoclase or soda-microcline with a striking

bluish or greenish shimmer-effect suggestive of labradorite. The ferro-magnesian minerals include augite, biotite, and hornblende, but are not abundant. In the office of the Agent-General of New South Wales are pillars of granite with porphyritic white felspars, of a type common among the granites of Cornwall and Devon.

Figure 12 represents the beds passed through by a well in Trafalgar Square.

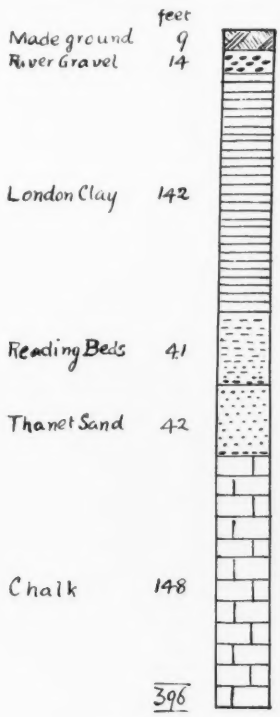

FIGURE 12.

Passing down Whitehall and Parliament Street, notice on the left the new War Office, built of Coal Measure sandstone from Yorkshire in 1906. Just beyond it is the Banqueting Hall of Whitehall Palace, now the United Service Museum. It was built of Portland Stone by Inigo Jones in 1619. This stone, an oölitic limestone of Upper Jurassic age, was introduced into London by Inigo Jones, and was employed extensively by Sir Christopher Wren and others in the rebuilding after the Great Fire of 1666. The Government Offices on the west side of Parliament Street are built of Portland Stone, which is seen in its freshest and cleanest condition in those nearest the Abbey. Figure 13 shows one of the quarries at Portland. The two lower beds, known as the Base bed and the Whit bed, give the best building stone; above the Whit bed is the Roche, a coarse stone with hollow casts of shells, useful for engineering works, but of poor appearance. There is a capping of Purbeck beds, which are not used, but are stacked in the worked-out portion of the quarry, together with much of the Roche.

Take the next turning on the left and pass through New Scotland Yard to the Embankment. The lower parts of the police headquarters are of granite from the Prison Quarry on Dartmoor, but as the stone is unpolished its structure is already masked by a layer of London smoke.

On reaching the Embankment note that the river here flows almost due north; consequently Westminster Abbey has its axis at right angles to the Thames, while St. Paul's, at the next bend, lies parallel with the river. Notice also that Westminster is near the middle of this straight reach of the river: this is the most favourable position for a ford, because the deep water which borders the outer banks of curves is avoided. Here the Roman road, known as Watling Street, crossed the river on its way from Dover, afterwards following what is now the Edgware Road to St. Albans and Chester.

Pass the end of the Houses of Parliament, built in 1839 of magnesian limestone from the Permian of Derbyshire and Yorkshire, and enter Westminster Abbey by the usual entrance in the north transept. The greater part of the Abbey dates from the thirteenth century and the architecture is Early

FIGURE 13. A Quarry at Portland.

English, but Henry VII's Chapel is Tudor Gothic, or Perpendicular. The western towers are from Wren's designs, and the end of the north transept is later still. The earlier builders used chiefly Merstham stone, from the Upper Greensand of Surrey, and Caen stone, a limestone from the Middle Jurassic of Normandy. Restorations have been carried out with Bath stone, Portland stone, and other materials.

Within the Abbey the columns are of Purbeck marble, though in many cases the structure is not distinguishable. Good slabs of this stone, full of freshwater shells (*Paludina* or *Vivipara*), may be seen in the pulpit at the corner of the north transept and in Chaucer's tomb in Poets' Corner. The commonest marbles used in the monuments are the white statuary marble and the so-called Sicilian, white with cloudy grey markings, both from the great quarries at Carrara, in Northern Italy. The base of the Campbell-Bannerman monument, near the north-west corner of the nave, is a red marble from Laconia known as "rosso antico."

The Chapter House has some beautiful shafts of Purbeck marble, and in the Cloisters may be seen, at the time of writing, some of the old decayed stones that are being replaced by fresh material. The Merstham stone is easily distinguished by the flakes of mica and the dark green glauconite visible on the fractured surfaces. Blocks of chalk may also be seen in the Cloisters.

On leaving the Abbey, walk along Victoria Street to the Roman Catholic Cathedral of Westminster. This new edifice, built of brick in the Byzantine style, is a veritable museum of beautiful stones. In the porch two columns of Shap granite will be seen. Cross the western end of the nave, noticing the two columns of red Norwegian granite on bases of laurvikite, and pass down the south aisle. These terms are used in the same sense as in Anglican churches, where the altar is always at the east end; but orientation seems to be little regarded in modern Roman Catholic churches. The four columns between the nave and the aisle are of verde antico, a brecciated serpentine with patches of calcite from near Larissa, in Thessaly.

Between the aisle and the Chapel of Saints Gregory and Augustine are two columns of Swiss cipollino, a marble with green bands of talc or mica which somewhat resemble the layers of an onion, from which the marble is named. Cipollino from Greece forms the reredos behind the altar, the frontal of which is of yellow Siena marble. The west wall is panelled with verde antico and a purplish serpentine, rosso di Levanto, from Liguria, with a green and white marble above known as Campan vert, from the Pyrenees. The screen between this chapel and the font is supported on pillars of pavonazzo, a type of marble from Carrara in which the purple or brown veins have but little resemblance to the peacock from which it is named.

In the next chapel, St. Patrick's, the altar is of Irish black, Irish green (an ophicalcite from Connemara), and Irish red from Cork, with steps of a crinoidal limestone known as Irish grey. The altar in St. Andrew's Chapel is a slab of Alloa dolerite supported on pillars of red Peterhead granite with a base of grey Aberdeen. The walls are of blue Hymettian marble.

The south transept has columns of red Languedoc marble from the South of France in the centre, and of breccia di Seravezza, verde antico, and Greek cipollino at the side. The Lady Chapel is adorned with Campan vert, verde antico, pavonazzo, red marble from Seravezza, and pink and yellow Numidian.

The pulpit in the nave has tablets of red and green porphyry, porfido rosso and verde antico. These igneous rocks must not be confounded with the red marble and serpentine of similar designation. Porfido rosso antico, from Jebel Dokhan, in Egypt, has small white felspars in a dark red ground, and was named porphyry by the Romans on account of its purplish colour. Porfido verde antico comes from near Marathonisi, in Laconia, and, like the red porphyry, was much prized in ancient Rome.

The baldachino, or canopy over the high altar, is supported on eight splendid columns of yellow Verona marble with pedestals of verde antico, and the altar itself is formed of a single block of Cornish granite. North of the sanctuary is the Blessed Sacrament Chapel, decorated with yellow marble from Siena and rose de Numidie from Algeria.

Return along the north aisle, noticing the pillars of grand antique breccia from the Pyrenees in front of the Vaughan Chantry. In St. Joseph's Chapel the altar frontal is of Siena broccatello and Connemara green, and the steps are of white Carrara. In the next chapel, St. George's, the steps are white Pentelicon, the frontal verde antico and bresche sanguine, a red breccia from Algeria, and the reredos rosso antico. Here also are three columns of Algerian onyx marble or alabaster, somewhat misleading trade-names for a limestone of stalagmitic origin. The columns were intended for the baldachino, but were fractured in transit.

The walls of All Souls' Chapel are panelled with red and green serpentine, rosso di Levanto, and verde di Genova. The altar frontal is of yellow and black marble from Portovenere, near Spezia, and the wall above the confessional is of bardiglio fiorito. A column of laurvikite separates the chapel from the aisle. It would take too long to mention all the ornamental stones used in the Cathedral, but this brief account will enable the more prominent types to be identified.

THE BRITISH SCIENCE GUILD AND THE EDUCATION BILL.

Sir Alexander Pedler, the Secretary of the British Science Guild, has favoured us with copies of the following resolutions which have been sent to the Prime Minister and to Mr. Fisher :—

"Resolution passed by the Education Committee of the British Science Guild on the 5th November, 1917.

"RESOLVED, that in the opinion of the Education Committee of the British Science Guild, National Reconstruction, in order to be efficient, urgently demands, as a primary condition, that the Education Bill introduced by Mr. Fisher in the House of Commons on August 10th, 1917, should be proceeded with in the House without delay, and that after due consideration and such amendment as may be found necessary it should be passed into law during the present Session.

"Resolution passed by the Executive Committee of the British Science Guild on the 13th November, 1917.

"RESOLVED, that the Executive Committee approve and adopt the Resolution of the Education Committee as to the Education Bill, introduced in the House of Commons in August last, for transmission to the Prime Minister."

THE WEATHER AND ITS ANOMALIES.

By TANKERVILLE CHAMBERLAINE, Bey.

THERE has been a number of enquiries made for several months with regard to the continuation of unusual weather. We have had a succession of cold months without respite, resembling a prolonged winter. There has been a series of snow, sleet, and hail storms, and rain accompanied with a high temperature produced by strong cold winds from the north, north-east, and north-west. In some parts of our island the west and south-west breezes, which generally are balmy or warm, have been nearly of the temperature of those from the north, north-east, and north-west.

These meteorological phenomena have been the subject of frequent arguments. From them I have selected two principal theories gained by the experience I have had in observing atmospheric changes and conversions of climate in different parts of the world, and which has induced me to give my opinion on this complex topic. It may be interesting, and I hope that, as far as I can judge from experience and observation, it will be the most probable solution.

Many have a theory that gun-firing has been the cause of a considerable displacement of air in different parts of our globe. In Europe, on the western front (France and Belgium), in Austria, Bulgaria, Greece, Italy, Russia, and Serbia; in Asia, Mesopotamia, Persia, and Armenia, in Egypt and Palestine; and finally in Africa. They argue that the concussion and displacement of air in all its various oscillations in these different sectors of our universe tend to remove the local strata of atmospheric properties and effect violent rushes to establish the natural equilibrium disturbed. These abnormal supersedures, it is alleged, change or confuse the course or movements of the aërial currents and derange the regular conditions of season or climate. I have witnessed in Texas gun-firing which produced a copious fall of rain. These atmospheric oscillations, which travel from these different sectors, become a great circle and return to their original position.

The second theory adduced is that there has been a deviation in the Gulf Stream occasioned by submarine convulsions from the giant chain of the volcanic regions of the Andes, extending from Mount Chimborazo and Cotopaxi (Ecuador) through the Cordillera (Panama range) and Gulf of Mexico to Mount Popocapatetl, thus interfering with the action of the Gulf Stream. I have experienced on two different occasions, once on board the "Retriever" (cable ship) stationed at Colon, the effects of an earthquake. The sea became troubled and produced a swell which rose to a height of ten feet. I was again a few weeks afterwards, in September, 1882, on board the "Silvertown" in the Pacific, near the island of Naos, when another earthquake supervened, lasting fifty seconds. The vessel trembled fore and aft, as if struck by a torpedo, and rose to a considerable height. A tidal wave immediately followed this disturbance and penetrated up to the town of Panama. I deduce from these two experiences that there is no doubt as to a submarine contact or commotion linking the radius of these volcanic regions.

The Stream current issues from the Gulf of Mexico and flows to the north-east. It is joined by a large body of water outside the West Indies, where it mingles with the waters of the North Atlantic. It has been surmised that there has been a deflection in its return to the Gulf of Mexico, thus deviating it from its course and depriving it of its normal temperature which affects the weather of our isles. Can we indicate more or less precisely where this deflection occurs? There is a deal of truth in this theory which may or may not be confirmed in future years; but to make it probable I will add this assertion, that what happened in Egypt in the construction of the Suez Canal has had a similar effect to our climate in the opening of the Panama Canal in relation to the Gulf Stream.

In my article on the rise and fall of the great Frenchman (*Chambers's Journal*, October, 1904) I pointed out that as soon as the Suez Canal was pierced, and the waters of the Red Sea and Mediterranean were wedded, Egypt changed its climate. I inhabited Egypt for fourteen years, and before the construction of the Canal I observed that for nearly two years we had no rain at Suez, but since its completion the climate changed and differed completely from the years 1863 to 1869.

Now that the Panama Canal has joined the Pacific Ocean to the Caribbean Sea and Atlantic, the Gulf Stream has deviated a part of its flow in its second or north-east branch to the West Indies, where the Stream mingles with the Atlantic, takes its course across the Caribbean Sea, passes through the Canal, and flows into the Pacific Ocean. The tide will certainly flow easily through the Panama Canal as the difference of the rise and fall is most accentuated. The Atlantic rises and falls six inches and the Pacific twenty-one feet.

I allege that a fall of temperature is felt in the north equatorial division, being deprived of a volume of the Gulf Stream which flowed in the direction of the North Atlantic to Cape St. Roque. The second branch, the more powerful of the Stream, is the one, a part of which has been deflected in the Caribbean Sea through the Panama Canal. I think it expedient to mention here in conclusion that on August 27th, 1883, when the Krakatoa cataclysm in Java happened, I took observations with a maréograph (a French title of an instrument to measure the nature of the tides) at the moment of this volcanic eruption. In the Indian Ocean the submarine commotion affected Ceylon, and in the Pacific the succession of waves that were generated reached Cape Horn, a distance of eight thousand miles f om their central propagation, and at Rakata formed below the level of the sea a cavity of one thousand feet. Mountains of earth were lavishly ejected, creating new islands in the vicinity of the Sunda Strait, which deflected—as submarine convulsions may do in the volcanic region and affinitive radius of the Gulf of Mexico—the northern currents of the Java Sea and those of the southern coast of Java and Sumatra around the islands of Nassan and Simalur. I sent the diagram of these observations taken at Colon, with regard to the Caribbean Sea and Atlantic Ocean, and at Panama concerning the Pacific, to Sir Thomas Evans, R.N., the Hydrographer of the Admiralty at that date (1883). The diagram represented an extraordinary phenomenon. The tide there rose and fell continuously for twelve hours in ripples of undulating zigzag waves; in fact you may call them "fluctuating dancing waves" of an altitude of two feet, most abnormal for a tide of only six inches. This seems to confirm what I have expressed above with regard to the Gulf Stream, that there is no doubt of a submarine connection or affinity with these seismic disturbances which act upon our climate. We have had from 1882 to 1917 several of these volcanic events in the different centres of the world.

WOODEN SCRATCHING TOOLS MADE BY AN AFRICAN PARROT.*

By NINA F. LAYARD, F.L.S.

STUDENTS of the evolution of flint implements often urge that a very long period of experiment was necessary before man finally arrived at producing anything so advanced as a Palaeolithic

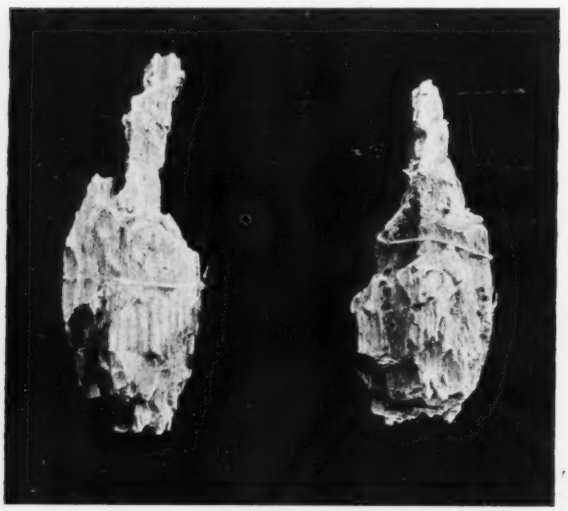

FIGURE 14.
The most usual type of Parrot's Scratching Tools.

tool. Even the crude forms of weapons of still earlier cultures are not considered sufficiently vague in outline and intention to fit the extremely low intellectual capacity attributed to *Homo sapiens*.

I confess to having listened to these oft-repeated arguments with a growing sense that those who held these views were denying to man alone, of all the animal creation, even the common heritage of instinct, let alone the rudiments of reason,—if indeed there be a really hard-and-fast line between the two. That a certain amount of inventive ingenuity is noticeable in some of the lower animals, under the stress of new environment, it would not be hard to prove, and the reasoned adaptability of man may be but a higher degree of the same faculty.

We are not, unfortunately, at present in a position to prove what man could accomplish in the way of fashioning tools in his primitive state; for, even among the lowest tribes yet encountered, language and consequently tradition must have played their part in the passing on of earlier inventions. If, however, we discover that tool-using, in some cases developing into tool-making, is an accomplishment not unknown to the dumb creation, we may possibly get a hint as to the sequence of circumstances which led up to the final triumphs of the human tool-maker.

A few years ago I was the fortunate possessor of a grey African parrot which not only made use of natural tools (a habit known to belong to the parrot tribe), but so fashioned, or refashioned, them as to encourage me to venture to call her a "tool-maker." The bird formerly belonged to the late Dr. Gibb, of Ipswich, who told me that he had never himself observed this performance; but it is probable that the necessary material was not supplied while it was under his care.

Like most of her kind, the parrot was partial to having her poll scratched, and as few could resist the insinuating proffer of her head for the purpose, this grew to be an obsession. As a limit had to be put to the indulgence of this propensity, the bird set about to discover how to satisfy the craving on her own account, and for this purpose she was found to be selecting from the food tray the long pointed seeds of the sun-flower and the oval seeds of the marrow for use as grattoirs. These she held in her claws and applied to head and neck, some-

FIGURE 15.
A Tool, pointed at either end, showing Ogival Curve.

times spending quite a long time over the comforting operation.

It may be argued that this habit was accidentally acquired in the following way. Supposing the

* A paper read before the Linnean Society, April 19th, 1917.

seed to have been taken from the tray for the purpose of food only, but an irritation of the scalp coming on at that moment, the bird, loth to lose the seed, but anxious to allay the irritation, might continue to clasp it while she used her claw as a grattoir, thus accidentally bringing the seed point into contact with her skin. Though it is necessary to suggest every possible accident that might have led up to this habit, it is more reasonable to suppose that the bird had sufficient intelligence to recognise that a point was required for scratching. At any rate, after discovering that this naturally formed tool was an improvement on her own sharp talons, she had the sense to continue the use of it. Such devices are not unknown among other parrots.

After this there arose a difficulty; for, finding that by no twisting about of the head, or contortions of the body, could the shoulders and wings be reached, it was evident that longer tools must be requisitioned. As it happened to be moulting time, these were soon discovered ready to hand, and it was a pretty sight to see the bird, balanced on one foot and with a gorgeous red tail feather or a grey wing feather grasped in the claws of the other, manipulating head, neck, and shoulders with the quill. Again, it may be urged that, as some birds nibble the ends of their quills, the parrot had grasped the feather for this purpose; but she was never seen to indulge in this tiresome habit, which often ends in the birds stripping themselves of their plumage; so it appeared that the quill was expressly chosen for use as a scratching tool.

But moulting time does not last for ever, and the feathers were cleared away. About this time I made the experiment of giving her one of Bryant and May's safety matches, after breaking off the tip. Instead of destroying it, she was seen to sharpen it to a point, and immediately made use of it as a scratcher. This experiment was often repeated, and observed by several members of the household.

As the bird was an inveterate perch-biter, she was provided with wood or sticks to prevent the destruction of the cage. Wood kindling was given at first, and it seemed to be the height of her ambition to succeed in working off the splinters from end to end of the wood without breaking them. In this she was remarkably clever. Later I substituted a softer wood, as there was a danger of the tongue being pierced by splinters, and it was then that tool-making commenced in earnest. To my surprise, after watching the bird engaged for a long time in combing herself, I discovered that she was holding a small piece of wood shaped into a cunning little grattoir (see Figure 14). After this it was a common thing to see her biting off pieces into convenient lengths and sharpening up what was still left in her grasp, or picking up from the floor the short pieces of wood which had been dropped, and pointing them for use.

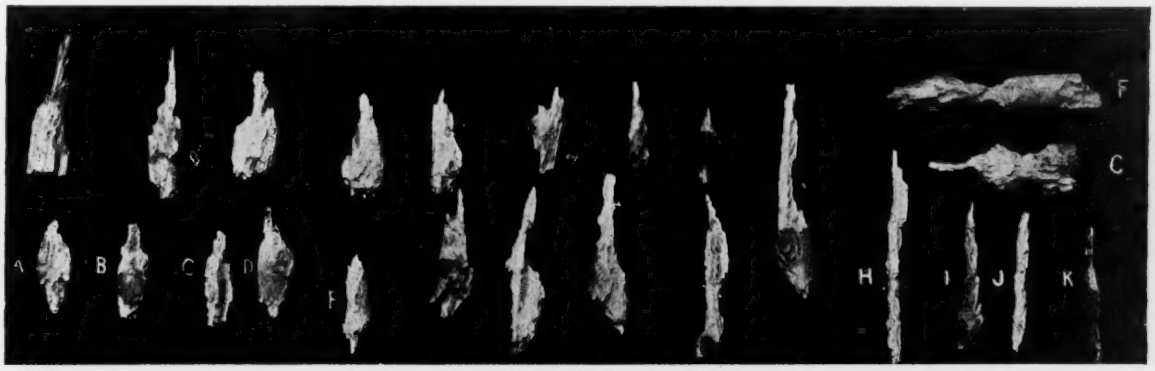

FIGURE 16. Tools made by the Parrot.

When seeking the pith only, the parrot would split a stick longitudinally and work straight down it, abstracting the pith and producing splinters, as shown in Figure 16, H–K; but though these were occasionally pointed afterwards, the procedure was different when the bird was intent on producing scratching tools only. The following notes I took down on December 31st, 1911, when watching the operation. A rotten stick, measuring about four and a half inches in length, was given to the bird. This was held in the claws of the right foot. She commenced by stripping off the bark, turning the stick round meanwhile. Then, starting about an inch and a half from the top, she proceeded to nibble nearly through the stick. Taking the wood in her beak, she now turned it upside down and commenced working in the same way one and a half inches from the other end. This time she bit the stick right through, dropping the upper portion and retaining the other two almost divided sections. In this case, being tired with the long exertion, she flung the rest down without properly finishing the work. The same afternoon I gave the parrot a new piece of wood measuring five and a half inches in length. She again commenced by stripping off the bark, and, as if uncertain where

to begin, turned the stick round, examined it, turned it back again, and then proceeded to nibble the wood two inches from the top. The severing of this portion was not, however, completed; for again the stick was reversed, and at one and a half inches from the opposite end she started working, and did not rest till it had been completely severed. The whole operation took nearly twenty minutes. The examples of her handiwork here illustrated were collected in a few days. I much regret to say that numbers of the tools had been already thrown away, for she was a busy carpenter (Figure 16, F and G, shows tools in the making). The usual form was with the humped handle and short point. These might have been multiplied indefinitely, but, sad to say, after I had just commenced to make a serious study of these facts, my feathered friend died of pneumonia during my absence from home. Three small sketches of the parrot in the act of using the tools had, however, been made.

The proprietor of a cinematograph company was also invited to take films showing the parrot at work, both making and using the implements; but the subject was not considered of sufficient interest to warrant the expense involved.

Figure 17. A Palæolith from St. Acheul.

Man has been distinguished from the lower animals as a "tool-maker," and although this definition may have been modified by recent discoveries in the animal world, there is no doubt that if it can be proved that this parrot shaped out even so much as a point with the object of using it, a contribution will have been made to facts which may eventually disprove the distinction. But the question must be fenced by every possible suggestion as to any other motive possibly influencing the worker.

The fact that the wood which was substituted contained a pith, which was palatable, might argue that in order to obtain it the bird was induced to bite into the wood rather than to destroy it ruthlessly at once. Did the point originate in this way? Quite possibly. But this is certain, that finding the convenient shape to hand she made use of it as a scratcher, and, what is of infinitely more importance, repointed it when it became blunted through use and immediately used it again. This refashioning of the points was continually witnessed by members of my household, and all were agreed that its sole purpose appeared to be that of making the wood penetrate the feathers better. If we allow even as much as this, the bird had become not only a tool-user, but a tool-maker. It must be remembered that the match was also nibbled before being used, and this, of course, contained no pith. Figure 16, H, is a pointed tool made of wood kindling without pith.

Another habit of the parrot is not without interest. When the point of a wooden tool from constant resharpening became too short for further use, the tool would often be turned round and shaped at the other end. A result of this manœuvre was the production of the ogival curve, so well known in late St. Acheul flint tools (see Figure 17). When the bird grasped the wood in the right foot, and worked out the point from one position, it was seen to incline to one side instead of being straight. Then, when the implement was reversed, and the same process repeated, the new point took an opposite direction, thus causing the twisted appearance already referred to.

I cannot claim for this clever bird that she was the first parrot to use natural tools, for I learn from several observers that the habit is not unknown to them. Mr. Saunders, bird-fancier, of Ipswich, has seen an Amazon parrot making use of a quill, and it seems to be a common practice among the rose-breasted variety of cockatoos. He has also noticed one of these birds using a cuttle-fish bone; but whether sharpened up or not he did not know. A very large number of parrots have passed through his hands, but he has never observed the manufacture of wooden tools by any of these birds. The merry-thought of fowls may be

added to the list of objects in the parrot's tool chest.*

The analogy between the early flint workers' methods and that of the bird which I have ventured to call a tool-maker is instructive. When working on a Palaeolithic site on the Foxhall Road, Ipswich, I found in one part of the excavation, lying very near together, thirty-three small knife-like flakes of a variety of shapes. More than once I had come upon similar nests of flints, which I did not at first recognise as tools. My attention was, however, drawn to them by finding that about a third of the specimens had received intentional blows, either to render them flat and sharp or, in the case of thicker flakes, to give them a scraping edge. It soon became quite evident that the greater number were merely selected pieces of flint which had been gathered together as being suitable for the work of cutting or scraping skins, but that when the natural supply failed, the worker purposely removed a few flakes or chips from suitable pieces to produce the required edge. In a similar way the bird commenced by selecting natural tools, improving upon them, as in the case of the pointed match, and finally, apparently of set purpose, pointing and repointing what presently had all the appearance of tools proper.

Since writing this paper the writer has received the following confirmatory evidence from Professor Marcus Hartog, of University College, Cork. In his "Problems of Life and Reproduction" (John Murray), Progressive Science Series, 1913, page 226, Professor Hartog wrote as follows: "Accident may invent a machine; reflection will duplicate it. The late Professor Morrison Watson told me that his parrot, while playing with a bit of stick which it had gnawed to a point, casually scratched his back with it, and evidently liked the sensation. Thereafter, whenever he was given a bit of stick, he deliberately sharpened it first and then used it as a scratch-back [page 228]. Only the highest organisms can make complex machines, it is true; but the beaver's dam, the parrot's scratch-back, the nest of the bird or insect, and even the cemented shell of the lowly Foraminifer are all included under our definition."

* This information I have received from Mr. Bennett, of Ipswich.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

FURTHER NOTE ON PROFESSOR BARNARD'S STAR.—In the last number of "KNOWLEDGE" a "stop press" note which I added on the latest results of the parallax observations was unfortunately printed under the heading "Metcalf's Comet," so it is as well to repeat the information. Several photographic investigations of the parallax were made at American observatories. Professor Schlesinger finds 0″·52, Dr. Mitchell 0″·47, Dr. Lee 0″·55. The mean value is 0″·51, which cannot be far from the truth. The star's distance is six and a half light-years, or half as far again as α Centauri. It is the nearest known star in the northern celestial hemisphere.

The following list of the fifteen stars with the greatest known parallaxes may be of interest. I have made use of Rev. O. R. Walkey's useful catalogue (*British Astronomical Association Journal*, April, 1917).

Parallax.		Star.
″		
·76	...	α Centauri and Innes Star.
·51	...	Barnard Star.
·40	...	Lalande 21115.
·38	...	Sirius.
·36	...	Piazzi O^h, 130.
·33	...	ϵ Eridani.
·32	...	Procyon and Cordoba V. 243.
·31	...	τ Ceti.
·29	...	61 Cygni, Lacaille 9352, BD $+59^\circ$·1915.
·28	...	ϵ Indi and Groombridge 34.

The parallax of 61 Cygni now accepted is practically the same as that given by Bessel, and indicates a distance of eleven light-years. It is curious that several observers in the period from 1860 to 1890 agreed in giving a larger parallax in the neighbourhood of 0″·4.

A NEW EMPIRICAL LAW OF PLANETARY DISTANCES.—Since the conspicuous failure of Bode's Law in the case of Neptune, many attempts have been made to form other laws. The labour is not useless, for there may be some physical cause underlying these approximations.

A law of a very simple character has been put forward by G. Armellini. He takes the number 1·52, representing approximately the distance of Mars from the Sun, that of the Earth being unity, and observes that various powers of this number give close approximations to the planetary distances, thus:—

				Planet.	True Distance.
$1{\cdot}52^{-2}$	=	0·433	...	Mercury ...	0·3871
$1{\cdot}52^{-1}$	=	0·658	...	Venus ...	0·7233
$1{\cdot}52^{0}$	=	1·000	...	Earth ...	1·0000
$1{\cdot}52^{1}$	=	1·520	...	Mars ...	1·5237
$1{\cdot}52^{2}$	=	2·310	)		
$1{\cdot}52^{3}$	=	3·511	)	Asteroids.	
$1{\cdot}52^{4}$	=	5·338	...	Jupiter ...	5·2028
$1{\cdot}52^{5}$	=	8·115	...	Saturn ...	9·5389
$1{\cdot}52^{6}$	=	12·334	...		
$1{\cdot}52^{7}$	=	18·749	...	Uranus ...	19·1826
$1{\cdot}52^{8}$	=	28·498	...	Neptune ...	30·0370
$1{\cdot}52^{9}$	=	43·318			
$1{\cdot}52^{10}$	=	65·845			
$1{\cdot}52^{11}$	...	100·09			

From Mercury to Jupiter the new law is nearly as accurate as Bode's, but there is a poor representation of Saturn and Neptune: the author conjectures that there may be an undiscovered zone of minor planets beyond Saturn.

The representation of Uranus is very fair. I have carried on the series to three terms beyond Neptune. It is interesting to note that Professor Forbes from a study of cometary orbits conjectures a planet at distance 100, period 1000 years. According to the series this would be the third planet outside Neptune. It may be noted that eleven terms of the series give a recurrence of the same figures multiplied by 100; *i.e.*, the first planet beyond Neptune would be at one hundred times Mercury's distance, the next at one hundred times Venus's, and so on. In other words, the logarithm of the number 1·52 is almost exactly 2/11.

In the above table I have not taken the exact value 1·52, but the number whose logarithm is 0·1818525, which I

found from the mean of the seven planets. A larger value would give better results for the outer planets.

COLOURS OF PLANETS AND STARS.—Professor W. H. Pickering gives a colour scale in *Popular Astronomy* for August for comparison with the colours of heavenly bodies. He has twelve coloured discs numbered as follows: Five deep blue, six sky blue, seven light blue, eight pale blue, nine bluish white, ten white, eleven yellow, twelve orange, thirteen red-orange, fourteen orange-red, fifteen light red, sixteen deep red. He advises the use of a tungsten lamp with blue shade to illuminate the scale. Stars should be put out of focus to give a larger surface. Saturn's ring, Jupiter's light equatorial zone, and Pollux were all found to be colourless (10 on the scale). The Sun (reduced by repeated reflexions from plane glass) was $8\frac{1}{2}$ to 9, the sky was 6, a white cloud $9\frac{1}{2}$, Arcturus and β Ophiuchi $10\frac{1}{4}$, γ Leonis $11\frac{1}{4}$. Afterwards it was decided to add a systematic correction of one unit to the star readings to bring them into accord with current estimates. The mean colours of the various spectral types thus corrected were found to be Oe 7·0, B 6·7, A 7·4, F 7·6, G 9·5, K 11·5, M 12·0, N 13·7.

This would be interesting work for amateur observers. If applied to different regions of the Moon and planets it might lead to useful results.

NEW STARS IN SPIRAL NEBULAE.—It will be remembered that a Nova appeared in 1885 in the Great Andromeda Nebula. There have lately been some similar appearances in other nebulae. Mr. Ritchey discovered one in N.G.C 6946, whose coördinates for 1917 are R.A. $20^h\ 33^m\ 3^s{\cdot}1$, N. Decl. 59° 50′ 15″. Its greatest brightness was about 11. It was situated near the southern end of an arm running obliquely from east to south of the central star. It faded pretty rapidly.

On examining photographs of the nebula NGC 4321, R.A. $12^h\ 18^m$, N. Decl. 16° 23′, Dr. H. D. Curtis found images of two novae. One appeared about March, 1901, magnitude 13·5. It was 110″ W., 4″ N. of the nucleus. It has now disappeared. The other was of magnitude 14 in March, 1914, 24″ E., 111″ S. of the nucleus

It need scarcely be added that these repeated instances leave no doubt that the novae were really in the nebulae, and not merely optically projected upon them. This affords a further resemblance between the spiral nebulae and our own Galaxy. We may attempt to deduce a rough idea of the distance of these novae. From their short durations they might be of about the same absolute brightness as Nova Aurigae, whose maximum magnitude was 4. The drop of seven or eight magnitudes implies a distance thirty or forty times as great. We do not know the distance of Nova Aurigae, but if we put it at one thousand light-years, we shall probably be in the neighbourhood of the truth.

MR. INNES'S PROPER-MOTION STAR.—Two years ago Mr. Innes found (by the blink method of comparing photographic plates) a star of the eleventh visual magnitude and thirteenth photographic which had a large proper motion. Both he and Mr Voûte (of the Cape Observatory) now find that the star has the same parallax and proper motion as α Centauri, from which it is distant 2° 11′·2 in position angle 147°. Supposing it to be revolving round α Centauri, we can make a rough estimate of the period as follows. The average distance between the components of α Centauri is about 12″, and the period eighty-one years. The distance of the small star is about six hundred and sixty times as great; whence the period would be $81 \times 660^{\frac{3}{2}}$ years, or $1\frac{1}{3}$ million years.

In this computation the mass of the small star is neglected, and the line joining it to α is assumed to be at right angles to the radius vector. A million years would seem to be the minimum period possible.

Mr. Voûte notes that the absolute magnitude, at a distance of thirty-two light-years, is 15·4 visual, or 17·9 photographic. The Sun would be of the fifth magnitude, at least ten thousand times as bright as the star. Its temperature and surface brightness must be very low. Mr. Innes suggests the name Proxima Centauri for this little object. Place for 1916·0 R.A. $14^h\ 23^m\ 54{\cdot}28$, S. Decl. 62° 19′ 10″; proper motion, 3″·76 in direction 282°·7.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

TOXIC ACTION OF ARSENATES.—An investigation has been made by Messrs. Lovett and Robinson (*J. Agric. Res.*, 1917, X, 199) to ascertain the relative efficiency of different kinds of arsenates when used in the form of a spray to destroy caterpillars. It was found that solutions of lead hydrogen arsenate were decidedly more effective than solutions of calcium or basic lead arsenate of the same strength for destroying the common tent caterpillar (*Malacosoma pluvialis*). The amount of arsenic retained by insects feeding upon leaves sprayed with the solutions varied with the nature of the arsenate. For example, in the case of lead hydrogen arsenate most of the arsenic was retained by the tissues, whereas when basic lead arsenate was used a large proportion of the arsenic was rapidly eliminated. It required about 0·1595 milligramme of arsenic pentoxide to kill one thousand small tent caterpillars, and about 1·84 milligramme to kill the same number of nearly mature caterpillars. Preliminary experiments with sprays of calcium arsenate and calcium ammonium arsenate showed that they caused too severe injury to the foliage of trees to be safe materials for the purpose.

FOOD SUPPLIES UNDER PRESENT CONDITIONS.—Mr. A. Smetham, F.I.C., recently brought before the members of the Royal Lancashire Agricultural Society some of the scientific facts and statistics upon which the Orders with regard to rationing must have been based, and his paper has now been published in the form of a pamphlet. In discussing the subject he draws largely upon a report of a committee of the Royal Society, "The Food Supply of the United Kingdom," for his facts. In this report it is shown that in converting vegetable foods into human food in the form of animal products considerable loss is incurred, the amount of which varies with the animal. This is shown in the following table:—

1-lb. Starch equivalent in fodder required to produce 1000 calories in the form of	
2·9	Milk from good Cow
3·0	Pig Meat
4·7	Veal
4·7	Milk from bad Cow
5·3	Mutton
7·0	Eggs
7·0	"Baby" Beef
9·0	Steer Beef

Thus the most economical form of "converting" vegetable into animal food is by means of a good cow in milk; whilst the most expensive is "steer" beef, which costs three times as much as pigs' meats. Under the most favourable conditions, the milk produced by a good cow has only about two-sevenths of the food value of the food from which it was produced.

The population of the United Kingdom in 1911 was estimated at 45,273,631, but for food-consuming comparisons this would be equivalent to about thirty-five millions of healthy men. The daily requirements per "man" were estimated by the committee at a minimum of one hundred grammes of proteins, one hundred grammes of fat, and five hundred grammes of carbohydrates, equal to about three thousand four hundred calories per "man" per day; or to meet the requirements of the population as a whole

the amounts required would be: Proteins, 77 grammes; fat, 77 grammes; and carbohydrates, 385 grammes.

To meet these requirements the foodstuffs, home-grown and imported, from 1909 to 1913 were capable of supplying the following quantities:—

	Protein, grammes.	Fat, grammes.	Carbohydrates, grammes.	Calories.
Per head	87	100	440	3091
,, 'man'	113	130	571	4009

Thus during the past, as the committee points out, there has been a waste, or excess consumption, of eleven to fourteen per cent. of proteins, twenty-five to thirty per cent. of fats, and ten to fourteen per cent. of carbohydrates. Taking the voluntary rations of bread 4-lb. (or flour 3-lb.), meat 2½-lb., and sugar ½-lb. per week, Mr. Smetham calculates that they would supply the following amounts daily per head of population:—

	Protein, grammes.	Fat, grammes.	Carbohydrates, grammes.
From 3-lb. of Flour =1360 grammes ...	22	2	146
From 2½-lb. Meat ...	21	48	Nil
From ½-lb. Sugar ...	Nil	Nil	32
	43	50	178

Hence there would be a deficiency of thirty-four grammes of protein, twenty-seven grammes of fat, and two hundred and seven grammes of carbohydrates, which would have to be obtained from other foods.

Mr. Smetham then proceeds to show that the home-grown foods of all kinds do not come up to the minimum standards, and that without imported food there would be semi-starvation for lack of carbohydrates, and great waste of protein and fat to make good the deficiency.

After briefly indicating the measures that have been adopted to husband our food supplies, and making suggestions as to the future, Mr. Smetham deals with the conclusions of the committee upon the brewing question. In these it is pointed out that, assuming that no food value is ascribed to the alcohol, 27·9 per cent. of the original materials are available as human food, as against 71·7 per cent. if used directly; and hence Mr. Smetham argues that, wasteful as brewing is, it is only about a quarter as wasteful as using the same materials as food for cattle.

GEOGRAPHY NOTES.

By ALEXANDER SCOTT, M.A., D.Sc.

MOVEMENTS OF THE EARTH'S POLE.—At various times, secular climatic changes have been ascribed to the motion of the Earth's pole; for example, the Pleistocene glaciations have been supposed to be due to excursions of the pole through 15–20 degrees of latitude. In a recent lecture to the Royal Institution, Colonel C. M. Hills discussed the question of the motion of the earth's pole, and described the recent work on the subject (cf. *Nature*, August, 1916). On the assumption of a rigid earth, Euler deduced a ten months' period for the motion, and, until 1884, the examination of all the observations was hampered by the adoption of this period. In that year, Chandler and Kustner commenced to reïnvestigate the question, and interesting results were soon obtained. Their work showed that the observed motion is made up of a precessional rotation of period fourteen months, and a smaller irregular motion. This work was confirmed by observations on the variation of latitude, but Kimura showed that the introduction of a third term of very small magnitude, and independent of the longitude, but of a period of one year, renders the results more consistent. By referring the whole motion to axes rotating in the earth with a period of fourteen months, the graph of the second term is obtained, and is seen to be very irregular. The causes are doubtless complex, and probably include the action of earthquakes, extensive barometric changes, and the transference of Arctic ice from one part of the globe to another. Of these, the first two causes are insignificant, and the third is probably the most effective in determining the irregular motion. The whole motion, however, is of a very small order of magnitude; and as there is no evidence of the magnitude having been greater in past times, it is practically impossible that it can have had any influence in determining the location of the Pleistocene glaciations.

GEOLOGY.

By G. W. TYRRELL, A.R.C.S., F.G.S.

A JURASSIC SHORE LINE.—The remarkable coarse breccias which are found in the Jurassic of Eastern Sutherlandshire, north and south of Helmsdale, have long been a puzzle to geologists. These deposits have been variously ascribed to earth-movements, brecciation by granite intrusions, river-action, or ice-action. Mr. M. Macgregor and Dr. C. B. Crampton, of the Geological Survey of Scotland, have, however, hit upon the correct explanation of them as cliff-talus, an explanation so simple and so obviously following from the observed facts that one wonders why it was not thought of before.

The breccia consists of angular blocks of Middle Old Red Sandstone rocks, piled up in bewildering confusion and cemented by a matrix of calcareous mudstones the lamination of which is frequently much confused and contorted around the included blocks. The numerous fossils found in the matrix fix the age of the whole deposit as Jurassic. The blocks range from quite small fragments up to huge masses, the largest of which is $150 \times 90 \times 30$ feet in size. This block is lying flat, with its stratification vertical, like a fallen stack, which, as a matter of fact, it is. The included blocks are exclusively derived from Middle Old Red Sandstone strata, identical with those now found along the Caithness coast. While geologists were seeking the answer to the problem of these breccias, the solution was being written for them along the Caithness coast, where the physiographical conditions under which the Jurassic breccias were formed are being exactly repeated at the present time. The Helmsdale boulder bed clearly represents a Jurassic cliff-talus formed at the foot of the Old Red Sandstone cliffs which then bordered the Jurassic sea. All the features of stack, skerry, and goe which now characterise the picturesque cliffs of the Caithness coast with the angular blocks of all sizes lying in a crowded mass at the foot, embedded in marine muds and sands of the present day, can be paralleled along this Jurassic coast line the record of which is preserved in the Helmsdale boulder bed.

AN AMERICAN VIEW OF THE OLD RED SANDSTONE.—Our British interpretations of the physical geography and climatic conditions of past geological periods probably suffer because of our insular position, and our consequent inability to observe and evaluate the importance of geological conditions under drier climates than our own. We are thus apt to minimise the extent to which sediments of fluviatile origin under semi-arid climatic conditions and sediments of true desert origin enter into the composition of British geological formations. Americans, however, who have a whole continent, with its many climates, to study, and with a great variety of conditions of deposition, have generally been led to a truer view of

the relative importance of continental deposition as contrasted with marine. Our Old Red Sandstone, once regarded as marine and then for a long period as the deposits of great inland lakes, is now believed by an acute American observer (Professor J. Barrell) to be of fluviatile origin in a region of seasonal rainfall in which alternations of semi-arid and rainy conditions were the rule (*Bulletin of the American Geological Society*, Volume XXVII, 1916). He distinguishes these conditions, and the resulting deposits, very carefully from true lacustrine conditions on the one hand, and from true desert conditions on the other. He bases his argument chiefly on the great thickness and areal extent of the Old Red Sandstone conglomerates, which could only have been deposited under fluviatile conditions. The great thickness of the deposits, the comparative abundance of fine-grained material with the distinctive marks of impersistent shallow-water conditions alternating with exposure of the beds to the air, visible throughout the whole series; and the presence of cornstone or kankar limestones are also regarded as evidences of fluviatile origin. The absence of millet-seed sandstones and salines proves the absence of true desert conditions, although some features of deposition under arid conditions may occur during the seasonal dry periods. On the other hand, the fine-grained, evenly laminated silts and paper shales of true lacustrine deposition are very subordinate in the Old Red Sandstone rocks, pointing to no more permanent or numerous lakes than usually occur in a great river system. "The conclusion has been reached from these studies that fluviatile deposition on the flood plains of inland basins was at that time an important mode of sedimentation. Seasons of flowing fresh waters over the regions of accumulation alternated with seasons of exposure to the dry air. On the outer zones sub-aërial delta plains passed into mud-bottomed shallow seas. In the inner basins shallow lakes with shifting margins were existent at times. At other times the lakes were reduced to pans of water evaporating in each dry season." The nature of the fossils preserved in the Old Red Sandstone supports this conclusion. A parallel is drawn between the climatic and physiographic conditions of the Old Red Sandstone and those prevailing in Tertiary times, and to a lesser extent at the present, within the great intermontane basins lying between the growing ranges of the North American Cordillera. Professor Barrell had evidently not seen the recent Geological Survey memoir on Caithness, or he would have found in it a close approximation to his own views on the origin of the Orcadian Old Red Sandstone. The only difference is that the Survey places somewhat more emphasis on lacustrine conditions. But even this appears to be largely a sentimental concession to the long-held lacustrine hypothesis; for, reading the memoir carefully, it is seen that the authors use the term "Lake Orcadie" for a great basin of long-continued fluviatile deposition in which large bodies of standing water were only intermittent and ephemeral phenomena.

RADIO-ACTIVITY.

By Alexander Fleck, D.Sc.

Since 1915 there have been very few papers published in British journals dealing with phenomena connected with radio-activity. Most of the workers in this branch of science have had their enegies directed to subjects which, in addition to being scientific, have a wider application to the every-day affairs of a nation at war. The energies of America have not thus been restricted—at least until recently—and one important paper is shortly summarised below.

SEPARATION OF ISOTOPES.—One of the first methods which were used to attempt the separation of elements suspected of being isotopic was fractional crystallisation. This was tried for uranium-X and thorium and for radium-B and lead, and was found to be of no avail. Richards and Hall have again taken up this method (*Journal of the American Chemical Society*, 1917, XXXIX, page 531), and use it in the case of lead obtained from Australian carnotite. They recrystallised the lead nitrate more than a thousand times and then determined the atomic weight of the first and the final fractions. The results obtained are 206·409 and 206·422 for the most soluble and least soluble fractions respectively. This difference is about six parts in one hundred thousand, which is well within the limits of experimental error.

This should surely satisfy most scientific men that isotopes are indeed a reality, and convince them that unless they have a process which is essentially different from any already used, it is a useless expenditure of time and energy to attempt to separate isotopes by ordinary chemical methods.

THE FUTURE OF THE BRITISH *x*-RAY INDUSTRY.—In April last the Röntgen Society held a discussion on the above subject which was opened by Mr. Geoffrey Pearce, and the interest aroused was so great that the discussion had to be extended over three meetings. The membership of this society is composed chiefly of medical men, manufacturers, and professional scientific men, and at this discussion the medical men and the manufacturers specified plainly each other's weaknesses. The general attitude taken up by the former was that they had been forced to go to Germany for *x*-ray apparatus because manufacturers here did not put the correct type of material on the market, while the position of the makers was that the medical profession had worked themselves into a mental attitude in which they were convinced that good apparatus came only from Germany. Both sides united in casting stones at the Government of this country for being behind-hand in supporting home industry. The contribution of Captain R. Knox, reported in the October issue of the *Journal of the Röntgen Society*, can be recommended very heartily owing to the common-sense view he takes of the situation. He speaks no more than the truth when he says—and it applies to manufacturers of other things besides *x-ray* apparatus—that if the manufacturers of this country want to have all our trade in their hands, one essential is for their products to be at least up to the standard of foreign-made articles.

The discussion throughout was most interesting, and might even be described as lively.

The Röntgen Society, along with perhaps the Faraday Society, has shown how it is possible to make a scientific organisation a thing of life, in contrast to the rather somnolent existence of some of the older societies.

ZOÖLOGY.

By Professor J. Arthur Thomson, M.A., LL.D.

"RUNTS."—This term is applied by breeders to undersized and abnormally light new-born mammals. Miss Helen Dean King has made a careful study of their origin and destiny in rats. They are produced when the litter is very large, or when the mother is not in good condition during the ante-natal period. They are handicapped, not merely by lack of nutrition, they are constitutionally handicapped. Their growth-capacity is so impaired that they cannot grow to the normal limit. Even if they grow up, they tend to have an abnormally small nervous system. They are lacking in reproductive vigour, and are fortunately in most cases unable to multiply after their kind. They are "better dead."

FOX WITH A FIRST HIND-TOE.—In wild members of the dog family (wolves, jackals, foxes, and so forth) the first hind-toe has quite disappeared. Professor Einar Lönnberg reports, however, its occurrence in a fox shot in Upland. The skeleton was unfortunately lost, but the toe is clearly seen on the skin. On the right foot the claw and both

joints were preserved; on the left the claw and one joint. There was nothing teratological about the toe; it is not rudimentary like the "spur" of some domestic dogs. "There is a very great interest connected with this fact, because it proves that an organ which has been completely lost during the phylogenetic evolution of a species may suddenly reäppear after a long period of suppression." It would be interesting to study the embryo fox.

PEARLS AND PEARLS.—There are various grades of more or less false or artificial pearls. (1) There are entirely artificial constructions, often of considerable beauty. (2) There are beads cut from the shells of various molluscs: red, pink, black, grey, yellow, white, and even variegated. These lack the concentric lines of true pearls. (3) There are "culture-pearls," which the Japanese produce by inserting some foreign body between the shell and the mantle of the living oyster. This gets covered with fine layers of nacre, and the result may be a very presentable pearl. Hitherto most of these pearls have been hemispherical "blisters," but round ones are now being produced. Mr. Alvin Seale notes that as regards texture and lustre these culture-pearls are indistinguishable from natural pearls, and thinks that in the hands of patient people pearl-farming can be made to pay.

HERMIT-CRABS AND THEIR PARTNER WORM.—H. N. Milligan relates in the *Zoölogist* an interesting experiment which ought to be carried further. In the shell inhabited by a common hermit crab (*Eupagurus bernhardus*) there is often a specimen of *Nereis fucata* which will put out its head to snatch pieces of food from the very jaws of the crustacean. The observer captured a specimen of the worm and placed it against he shell of a hermit-crab to see whether a stranger would be tolerated. The hermit-crab at once seized the worm and tried to eat it, and a hairy hermit-crab (*Eupagurus pubescens*) joined in the attack. But the worm escaped them both and retreated among the fine pebbles.

The hermit-crabs were removed from the aquarium and the tank remained empty for nearly three weeks, during which the nereid was not seen. When some newly captured hermit-crabs and a commensal sea-anemone (*Sagartia parasitica*) were placed in the aquarium, the worm reäppeared and tried to associate itself with one of the hermit-crabs. Partnership was vigorously refused, however, and the nereid reëntered the pebbles. On the third morning its remains were found in a half-digested mass encumbering the disc of the sea-anemone!

COLORATION OF NESTLINGS.—Mr. D. Seth Smith has called attention to the frequent occurrence of a striped colour-pattern found in very diverse types, *e.g.*, rhea, shel-drake, and pheasant. It is probably of very great antiquity, and inherited from some common ancestor. It is sometimes of protective value, making the nestlings inconspicuous in their surroundings. In other cases it has been modified or has even disappeared altogether. In most ducks the stripes have broken into spots; in gulls, waders, and others this has gone further; in geese, rails, and others all markings have disappeared.

FISH POISONING.—The wasteful method of employing vegetable poisons for stupefying or killing fish is of ancient origin and almost universal distribution. Messrs. Hamlyn Harris and Frank Smith have recently studied its occurrence among the aborigines of Queensland. Pounded or triturated material derived from many different kinds of plants is thrown into the water. Sometimes small fishes are stuffed with pounded vine-roots and then used to poison larger forms, and sometimes a palatable morsel is added. It is probable that the toxic properties are in most cases recognised as such, but a magical interpretation may linger. Effective and rapid in action at great dilution are active principles associated with ether-soluble resins in species of Derris, Tephrosia, Pongamia, and "Nero," and the sapotoxins of Careya, Cupania, Faradaya, and Garcinia. Less effective are the alkaloids of *Barringtonia speciosa* and *Stephania hernandiaefolia*.

JOURNEYS OF CRABS.—Various experiments have been made by the "marking method" to discover the extent and the rate of the movements of edible crabs. One of the recent records shows that three crabs labelled at Catterline, five miles south of Stonehaven, in Kincardineshire, in September and October were recaptured in January in the Moray Firth, near Troup Head and near Banff. They had travelled sixty-three and seventy-three miles, two at the average rate of half a mile a day and the third at the average rate of three-quarters.

ANT AGAINST ANT.—Dr. G. D. H. Carpenter, writing from the Forces near Victoria Nyanza, gives a vivid account of the long, solemn, slowly marching processions of black ants, *Megaponera foetens*, which search for a dark-coloured white ant or termite, which lives in holes in the open and runs about uncovered. It does not attack wooden posts or make covered ways. No soldiers were seen. When the foraging companies of *Megaponera* find the termites' hole there is great excitement. They scramble down, probably through underground barricades, and reäppear with the termites feebly struggling in their jaws.

SEA-CUCUMBER DIVIDING INTO TWO.—There have been some records of starfishes spontaneously dividing, and thus multiplying themselves. Now we have from Dr. Crozier a circumstantial account of the spontaneous division of a sea-cucumber, *Holothuria surinamensis*, which constricts across the middle of its body and is able to reconstruct a whole from each of the halves. The successful fission of a large and complex body is very remarkable.

ADAPTATIONS IN GOPHERS.—Very characteristic Californian rodents are the pocket-gophers (*Thomomys bottae*), which spend practically their entire life underground, making long tunnels several inches below the surface. Actual digging is accomplished by means of powerful downward and backward strokes of the fore-feet, the strokes being made alternately with the right and the left foot. The strokes are "so rapid that a continuous buzzing sound may sometimes be heard when the animal is working in hard ground." Three of the claws are extremely long and heavy; the sides of the fingers are provided with long, stiff bristles, which prevent dirt passing between them. The hand is thus a broad scoop when the digits are separated. "The loose earth is passed backward under the body by the fore-feet, and the hind-feet push it still farther back." Some say that the pocket-gopher uses its long upper incisors as a pick. Mr. Charles Daniel Holliger has made detailed comparisons as to bones and muscles between the gophers and other types—ground-squirrel, brown rat, cotton-tail, jack-rabbit, Belgian hare, and arboreal squirrel—and comes to some interesting conclusions. Burrowers have heavier and stronger instruments than runners or climbers. The bony levers of the gopher, with short power strokes, are so arranged that force is gained at the cost of speed; while in the rabbit, with long swift movements, speed is gained by sacrificing force. The idea that irregularity in the outline of bones indicates strength in the bone and muscle instrument is correct, but volume of bones is not a criterion of strength of body. The particular sets of muscles most used are either actually the largest or are made functionally strongest by the arrangements of the bony levers. The force of a given set of muscles depends both on its size and on its point of attachment to the skeletal parts. Domestication reduces specialisation. Thus the features typically associated with running have disappeared or have been much reduced in the Belgian hare. The "Belgian hare" is surely a rabbit, and not *Lepus europaeus*, as the author says.

CORRESPONDENCE.

DR. BASTIAN'S EXPERIMENTS ON THE ORIGIN OF LIFE.

To the Editors of "KNOWLEDGE."

SIRS,—I have pleasure in acknowledging the due receipt of the number of "KNOWLEDGE" containing the translation of our note on the verification of certain of Dr. Bastian's experiments.

Regarding the "interpretation" of the experimental results, I should be very pleased to look at the matter from the same point of view as Mr. J. Butler Burke, whose letter I read in "KNOWLEDGE." The micro-organisms which appear in the sterilised tubes are not identical in all points with those which we manipulate every day in the laboratory. They have, in common with these latter, several important properties, and that is all. I do not even believe that it is a question of spontaneous generation of organic matter, but I insist on this last point: life is not a chemically definable matter; it is a "state," a *manière d'être*, whatever chemical substance exhibits it under defined physico-chemical conditions.

When the electric spark pulverises the metallic electrode in distilled water in which it has been plunged, there is no formation of albuminoid matter; but there is determination of the colloidal state in the dispersed metallic particles, and one sees then these particles susceptible of producing catalytic actions which one had a tendency to refer only to defined species of organic ferments or of bacteria. Still more, coagulation renders them inactive, and the smallest additions of certain antiseptics absolutely paralyses their action.

In order thoroughly to understand the meaning of Dr. Bastian's experiments, it is, above all, necessary to study bio-physics, and again bio-physics.

ALBERT MARY.

LABORATOIRE MARY,
PARIS.
October 23rd, 1917.

AIR-WAVES.

To the Editors of "KNOWLEDGE."

SIRS,—On Wednesday night, November 7th, I woke suddenly, at about eleven o'clock, and heard a violent gust of wind that lasted but an instant, my window being shaken with a simultaneous "rat, tat, tat," and the sound of the gust passed away to the north-east. The whole, from the first rattle to the end of the passing-away sound, lasted not more than three seconds. My window was partly open, and so was that of my daughter-in-law in the next room. She heard the sound, and her door, which runs *into* the room, was burst open. I thought at the time that there must have been an explosion to the south-west, but have seen no notice of it in the papers. Judging by the time of the passage of the sound, the rate of that air-wave was about three hundred and fifty miles an hour. The night was a very still one.

DEVIZES. W. F. BADGLEY (Colonel).

REVIEWS.

BOTANY.

How to Collect and Dry Flowering Plants and Ferns.—By HAROLD STUART THOMPSON, F.L.S. 56 pages. 7½-in. × 4-in.

(George Routledge & Sons. 0/7 net.)

Mr. Thompson has something good to say on the value of a hobby, and the introduction to science which is given by making a collection. His little book is, as its title explains, devoted to the preserving of plants, and he gives much infromation and many details of usefulness and interest to all students of our flora.

W. M. W.

MATHEMATICS.

A Course in Interpolation and Numerical Integration for the Mathematical Laboratory.—By DAVID GIBB, M.A., B.Sc. 90 pages. 8½-in. × 5½-in.

(G. Bell & Sons. Price, 3/6 net.)

The importance of the branch of mathematics with which this volume—No. 2 of the "Edinburgh Mathematical Tracts"—deals is out of proportion to the comparatively small number of works dealing with it. The book, therefore, is especially welcome. Mr. Gibb's exposition is clear and precise, such as one would expect—though the expectation is not always, as in this case, realised—from a practical teacher. The book is divided into four chapters. In the first certain theorems in the calculus of finite differences, needed in later chapters, are proved and discussed. Chapter II deals with various interpolation formulae, namely, those of Lagrange, Newton, Stirling, Gauss, and Bessel. Fourier's analysis, it may be mentioned, is reserved for treatment in a later volume in the series, which has since been issued under the title of "A Course in Fourier's Analysis and Periodogram Analysis for the Mathematical Laboratory," by G. A. Carse, M.A., B.Sc., and G. Shearer, M.A., B.Sc. (66 pages, 1 plate, 8 diagrams; price 3/6 net), being No. 4 of the "Edinburgh Mathematical Tracts," and is in every way an admirable exposition of a rather abstruse subject. Chapters III and IV deal with the practical applications of the theorems and methods discussed in Chapters I and II, the former dealing with the construction and use of mathematical tables, more especially tables of logarithms; the latter with numerical integration—or mechanical quadration, as it is sometimes called—*i.e.*, the evaluation of the definite integral of a function from a series of numerical values of that function. One suggestion I should like to make is that in future editions of the book (which will no doubt be called for) something might be added concerning the calculation of trigonometrical tables, which require special methods of treatment. Interpolation formulae I have myself found very useful in this connection are:—

$$\sin(x+w) = 2\sin x \cos w - \sin(x-w)$$
$$\cos(x+w) = 2\cos x \cos w - \cos(x-w)$$

When $w = 0{\cdot}001$ radian, for instance, these become with an accuracy of at least ten decimal places:—

$$\sin(x+w) = 2\sin x - 0{\cdot}000001\sin x - \sin(x-w)$$
$$\cos(x+w) = 2\cos x - 0{\cdot}000001\cos x - \cos(x-w)$$

formulae whose use is extremely simple.

H. S. REDGROVE.

NOTICE.

THE CAWTHRON TRUST.—The late Mr. Cawthron left £250,000 to the city of Nelson, New Zealand, for scientific research. The trustees are the Bishop of the diocese, the member for the district, the Mayor of Nelson, two chairmen of local bodies, and a personal representative of the deceased. The site of the proposed institute has been purchased, and the appointment of a director and staff is under consideration. The object of the institute is, primarily, scientific research work for the benefit of the Province of Nelson and the Dominion of New Zealand. The Province of Nelson is mostly concerned with fruit, agriculture, and minerals.

XUM